RM 10.9 Cap Active/Sand Layer Composition: Determination by Core Testing and Mass Balance

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Introduction

The CPG is using a mass balance approach to determine whether placement of the RM 10.9 cap's active/sand layer is adequate prior to placing the geotextile and armor stone layer. This memorandum provides the rationale for, and results of, the mass balance approach used by the CPG. All measurements based on the mass balance approach verify that the active/sand layer placement in the areas both north and south of the No Dredge Zone meet the requirements of the Capping Specifications. Therefore, both areas are ready for placement of the armoring layer.

During the November 13, 2013 "Weekly Management Review of Capping Activities" conference call hosted by Stan Kaczmarek/dmi (participants from EPA Region 2, CDM, dmi, CH2M HILL, and GLDD), EPA Region 2 directed that the CPG also take cores of the RM 10.9 cap's active/sand layer after placement and analyze for % total carbon (or similar analytical test procedure). In a follow-up phone call on the afternoon of November 13 hosted by EPA (participants from EPA Region 2, CDM, dmi and CH2M HILL), EPA stated that they wanted chemical analyses of the active/sand layer's carbon content in addition to the thickness QA/QC measurements specified in the approved design. CPG participants on that afternoon phone call expressed concern regarding the extent of the sampling and whether such sampling and analyses would be appropriately representative of the active/sand layer. EPA stated that sampling some of the same cores that would be used for QC purposes would be sufficient. EPA and its consultant further noted that they expected the % total carbon results could vary considerably – by as much as +/- 50% of the design value. However, EPA wanted these data to help evaluate the RM 10.9 active/sand layer placement and to inform potential future capping on the Lower Passaic River. Therefore, in addition to the mass balance analysis discussed above, this technical memorandum provides active/sand layer core sampling and carbon testing analytical results that have been received to date.

Measurement of Active Material

As discussed in an earlier technical memorandum (CH2M HILL December 3, 2013) cap performance is governed by the amount of AquaGate+PAC™ and sand that is present in the active/sand layer. The final design AquaGate+PAC™ content is a minimum average of 30% and a minimum of 25% by volume, which is based on an overall 10-inch-thick active/sand layer thickness. As noted in the December 3 technical memorandum, increasing the amount of sand, while maintaining the necessary amount of AquaGate+PAC™, enhances cap performance even though the % AquaGate+PAC™ decreases. Thus, % AquaGate+PAC™ measurements can be misleading as the

% AquaGate+PAC™ may appear to fall below design criteria if the sand thickness exceeds the 10-inch design thickness. Because the actual placed active/sand layer thickness can vary from the 10-inch thickness upon which the final design is based, it is necessary to measure the adequacy the active/sand layer composition by a method other than % AquaGate+PAC™.

The CPG determined that the most accurate and representative method to determine the adequacy of AquaGate+PAC™ placement is to use a mass balance approach. The mass balance approach is used to calculate the equivalent depth of AquaGate+PAC™ application in an area. Results from both the mass balance approach and the carbon measurements required by EPA are presented in the following two sections.

Mass Balance Approach

The CPG utilized a mass balance approach for determining whether sufficient active/sand layer had been placed. The mass balance approach measured daily quantities of AquaGate+PAC™ deployed over a measured surface area and active/sand layer thickness. This mass balance method determines the actual placed AquaGate+PAC™ thickness and compares that value to the design criteria of a minimum average of 3.0 inches and a minimum of 2.5 inches of AquaGate+PAC™ (or a minimum average of 1.8 inches and a minimum of 1.5 inches of AquaGate+PAC™ in high subgrade areas). In addition, the active/sand layer thickness is evaluated to ensure its thickness meets design criteria of a minimum average of 10 inches and a minimum of 8 inches.

The mass balance approach is based on a large, accurate data set. That is, a known quantity of weighed sacks of AquaGate+PAC™ is deployed in a consistent, measured manner and the thickness of the resulting active/sand layer is measured. Importantly, utilizing the mass balance approach determines the adequacy of the active/sand layer placement in real-time without delaying cap placement while waiting for laboratory results.

AquaGate+PAC™ effective thickness results for the areas north and south and of the "No Dredge Zone" are presented in Table 3. All areas meet the AquaGate+PAC™ thickness design criteria. All active/sand layer thickness measurements also exceeded the minimum average of 10 inches (or 6 inches in high subgrade areas).

Table 3. Effective Thicknesses of AquaGate+PAC™

Date	*Volume of AquaGate+PAC™ Placed (cubic yards)*	*Area Covered by AquaGate+PAC™ (square feet)*	*Effective AquaGate+PAC™ Thickness* (inches)*
	Area South of the No Dredge Zone		
11/13/13	82	9,949	2.7
11/14/13	19	1,845	3.4
11/15/13	109	11,768	3.0
11/16/13	131	12,978	3.3
11/18/13	51	5,076	3.3
11/19/13	130	16,587	2.5
11/20/13	135	17,027	2.6
11/21/13	130	12,653	3.3
11/22/13	166	16,760	3.2

	Area North of the No Dredge Zone		
11/23/13	139	16,758	2.7
11/25/13	29	3,113	3.0
11/26/13	146	13,656	3.5
11/29/13	138	13,125	3.4
11/30/13	114	8,637	4.3
12/2/13	169	13,430	4.1
12/5/13	211	12,536	5.5

* Example Thickness Calculation for November 16, 2013 Active/Sand Layer Placement:
Volume of AquaGate+PAC™ Placed = 131 cubic yards (3,545 cubic feet); Area Covered = 12,978 square feet
Effective AquaGate+PAC™ Thickness = 3,345 cubic feet / 12,978 square feet = 0.27 feet = 3.28 inches

Carbon Analysis: Core Sampling and Analytical Results

Carbon content in the applied active/sand layer was evaluated by collecting cores of the layer post-placement at a rate of one core per day (equivalent to approximately one core per ½ acre). The cores were sent intact to the laboratory for analysis of total carbon via Method SM20 5310B-M. Results from the first five cores have been received and are presented in Table 1. The measured carbon values (1.7% to 2.3%) fall within EPA's anticipated +/- 50% of the theoretical mass percentages (see Table 2).

Table 1. Summary of Initial Active/Sand Layer Cores Analyzed for Total Carbon

Sample ID	*Date*	*Total Carbon (mg/kg)*	*Total Carbon (%)*
LPR-COR04A-131118	11/18/2013	17,300	1.7
LPR-COR05A-131119	11/19/2013	22,700	2.3
LPR-COR06A-131120	11/20/2013	22,600	2.3
LPR-COR07A-131122	11/22/2013	20,800	2.1
LPR-COR08A-131123	11/23/2013	17,400	1.7

Table 2. Example Calculations for Theoretical Carbon Weight Percentage

(a) Example Calculation for a 100 ft^3 Sand/AquaGate™ mixture containing 30% (v/v) AquaGate™

Weight of AquaGate™: 100 cu ft x 30% x 72 lb/ ft^3 =	2,160	lbs
Weight of Carbon: 10% by wt. of AquaGate™ =	216	lbs
Weight of Sand: 100 cu ft x (100% - 30%) x 90 lb/ft^3 =	6,300	lbs
Total Weight of 100 ft^3 Mixture =	8,460	lbs
AquaGate™ Weight Percentage =	25.5	%
Carbon Weight Percentage =	2.6	%

(b) Example Calculation for a 100 ft^3 Sand/AquaGate™ mixture containing 25% (v/v) AquaGate™

Weight of AquaGate™: 100 cu ft x 25% x 72 lb/ ft^3 =	1,800	lbs
Weight of Carbon: 10% by wt. of AquaGate™ =	180	lbs
Weight of Sand: 100 cu ft x (100% - 25%) x 90 lb/ ft^3 =	6,750	lbs
Total Weight of 100 ft^3 Mixture =	8,550	lbs
AquaGate™ Weight Percentage =	21.1	%
Carbon Weight Percentage =	2.1	%

Conclusions

All measurements based on the CPG's mass balance approach verify that the active/sand layer placement in the areas both north and south of the No Dredge Zone meet the requirements of the Capping Specifications. These areas are now ready for the next step -- placement of the geotextile liner and armor stone layer.